

PATENT COOPERATION TREATY

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/B2004/002623

International filing date (day/month/year)
21.07.2004

Priority date (day/month/year)
21.07.2003

International Patent Classification (IPC) or both national classification and IPC
H03M13/15

Applicant
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1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/IB2004/002623

Box No. II Priority

1. ☐ The following document has not been furnished:

☐ copy of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(a)).

☐ translation of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(b)).

Consequently it has not been possible to consider the validity of the priority claim. This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

see separate sheet

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-12,14,16-18
	No: Claims	13,15
Inventive step (IS)	Yes: Claims	1-12
	No: Claims	13-18
Industrial applicability (IA)	Yes: Claims	1-18
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item II.

The priority date, 21 July 2003, is valid in respect to the subject-matter of claims 1-12. However, the subject-matter of claims 13-18 is broader than the invention disclosed in the priority document. Consequently, the effective date of the subject-matter of claims 13-18 is the filing date 21 July 2004.

Re Item V.

1. Cited Documents

The following documents are referred to in this communication:

- D1 : Lin S. and Costello D.J.: *"Error Control Coding: Fundamentals and Applications"*, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1983, pp. 85-124 (XP002056639)
- D2 : Feng G.-L. and Rao T.R.N.: *"Reelections on the 'decoding of algebraic-geometric codes up to the designed minimum distance'"*, Internet Article, retrieved from <http://www.cs.mcgill.ca/~crepeau/PS/Feng-Rao.ps>, online 15 March 1995 (XP002287274)
- D3: Pellikaan R. et al.: *"Which linear codes are algebraic-geometric?"*, IEEE Transactions on Information Theory, May 1991, vol. 37, no. 3, pp. 583-602 (XP204363)

2. Independent Claims 13, 15, 16 and 18

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of **claims 13 and 15** is not new and the subject-matter of **claims 16 and 18** does not involve an inventive step in the sense of Articles 33(2) and 33(3) PCT, respectively. The reasons are the following:

- 2.1 Document D1 discloses a method of encoding information by means of a given code shortened in at least one predetermined position, comprising the method steps of:

- dividing a first polynomial representing information symbols by a generator polynomial so as to obtain a remainder polynomial (cf. D1, page 91, lines 22-23:

"Step 2: Obtain the remainder");

- calculating a second polynomial by subtracting the remainder polynomial from the first polynomial (cf. D1, page 91, lines 22-23: *"Step 3: Combine"* Remark: It is considered as general common knowledge that the subtraction and the addition are the same operations in binary Galois fields.);
- generating a pre-encoded word belonging to the given code from a sequence of coefficients of the second polynomial, so that the component of the pre-encoded word in the at least one predetermined position has a respective predetermined value (cf. D1, page 116, Section 4.7 Shortened Cyclic Codes: *"... Given a (n,k) cyclic code C consider the set of code vectors for which the l leading high-order information digits are identical to zero. ... "*);
- generating an encoded word by removing from the pre-encoded word the component in the at least one predetermined position (cf. D1, page 116, Section 4.7 Shortened Cyclic Codes: *"... The encoding and decoding for a shortened cyclic code can be accomplished by the same circuits as those employed by the original code. this is so because the deleted l leading-zero information digits do not affect the parity-check and syndrome computations."*);

Consequently, the systematic encoding method for shortened cyclic codes as disclosed in D1 has all the features of **claim 13**.

- 2.2 Independent **claim 15** specifies apparatus features corresponding to the method steps of claim 13. Following the argumentation given above, the subject-matter of claim 15 is known from the disclosure of document D1.
- 2.3 **Claim 16** specifies an information storage medium storing instructions of a computer program for implementing a coding method according to any of claims 13 and 14 and **claim 18** specifies a computer program product comprising sequences of instructions for implementing a coding method according to any of claims 13 and 14. Since the method of claim 13 cannot be considered as new for the reasons stated above, the subject-matter of claims 16 and 18 does not involve an inventive step.

3. Dependent Claims 14 and 17

Dependent **claims 14 and 17** do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT). The reasons are the following:

- 3.1 **Claim 14** additionally specifies that method steps as specified in claim 13 are used in a method of encoding for algebraic geometric codes. However, it is general common knowledge to a person skilled in the art that certain linear codes can be regarded as a special type of algebraic-geometric codes, e.g. Reed-Solomon codes (see for example, cf. D2, page 3, 5th paragraph) or Hamming codes (cf. D3, page 594, left column, Section V. Explicit Representations). Consequently, it is obvious for a person skilled in the art, that the systematic encoding of shortened cyclic codes, i.e. the systematic encoding for shortened Reed-Solomon codes or the systematic encoding for shortened Hamming codes as disclosed in D1, are also method steps for encoding an algebraic-geometric code.
- 3.2 The supplementary feature of **claim 17** relate to minor apparatus details for the information storage medium which do not add anything of inventive significance to the subject-matter of claim 16.

4. **Claims 1-12**

The subject-matter of **claims 1-12** is new (Article 33(2) PCT) and does involve and inventive step (Article 33(3) PCT). The reasons are the following:

- 4.1 The subject-matter of **claim 1** is an encoding method over a Galois field F_q for shortened cyclic codes which are not necessarily systematic.

The closest prior art document D1 discloses an encoding method for shortened cyclic codes, but the codes have to be systematic.

The main difference between the closest prior art document and the claimed invention is that components situated in arbitrary predetermined positions are set equal to a respective predetermined constant. In particular, the well-known systematic encoding using polynomial division with the generator polynomial is adapted to the case of shortened codes, whatever the positions of the

components for the codewords intended to be conserved (e.g. to zero). Hence, a MDS cyclic linear code C' with dimension (n',k') is shortened to a code C with dimension (n,k) whereby $n'-k'=n-k$, i.e. there is the same amount of redundancy in both codes C' and C . The resulting shortened code C is not necessarily systematic.

The technical effect of this feature is that an efficient encoding method for a general class of shortened MDS cyclic codes is developed. Hence, the objective problem of the present invention is to provide an encoding method for a general class of shortened MDS cyclic codes with a reduced complexity.

None of the prior art documents mentioned in the search report addresses this problem. Consequently, the features of the present invention cannot be regarded as obvious in view of the prior art documents.

- 4.2 The subject-matter of independent **claim 3** is an alternative encoding method over a Galois field F_q for shortened cyclic codes which are not necessarily systematic. Here the shortened code C is modified such that a further complexity reduction can be achieved during the encoding process.
- 4.3 **Claims 2 and 4-5** are dependent on claims 1 and 3, and as such also meet the requirements of the PCT with respect to novelty and inventive step.
- 4.4 **Claims 6-9** specify apparatus features corresponding to the method steps of claims 1-5. In view of the argumentation set forth above, the subject-matter of claims 6-9 is new and inventive with regard to the prior art documents.
- 4.5 **Claims 10 and 11** specify a non-removable and a partially or wholly removable data storage means comprising computer program code instructions for the execution of the steps of an encoding method according to any one of the claims 1 to 5. **Claim 12** specifies a computer program containing instructions such that, when said program controls a programmable data processing device, said instructions lead to said data processing device implementing an encoding method according to any one of claims 1 to 5. In view of the argumentation set forth above, the subject-matter of claims 10-12 is new and inventive with regard to the prior art documents.